



Solar Electric Propulsion

*Developing solar electric power and propulsion systems
for efficient travel beyond low Earth orbit*

Expanding Our Reach

Once they are placed into orbit and separated from their launch vehicle, spacecraft must rely on their onboard propulsion systems for any further maneuvering. For certain deep-space missions, the onboard propulsion systems and their required propellant may make up more than half of the overall spacecraft mass. By utilizing solar electric propulsion (SEP), the mass of the propulsion system and propellant can be reduced by up to 90 percent by augmenting the propellant with energy from the Sun. As a result, SEP is a cost-efficient method to transport cargo to the deepest reaches of space.

Lighter and Longer Mission Solution

NASA's Solar Electric Propulsion Technology Demonstration Mission will demonstrate a high-power SEP system for the Agency. It will

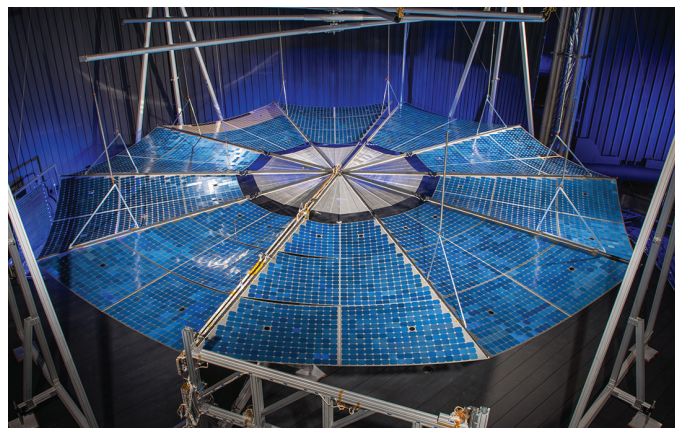
- reduce costs for interplanetary missions—including robotic and cargo missions to Mars;
- enable future long-duration, deep-space robotic exploration;
- lead to very high power systems for human interplanetary exploration; and
- demonstrate technology applicable to other government and commercial uses.

Technological Advantages

Mission needs for high-power SEP are driving the development of advanced technologies including large, light-weight solar arrays, magnetically shielded ion propulsion thrusters, and high-voltage power processing units. Utilizing electric power from solar arrays to ionize and accelerate xenon gas, highly efficient thrust is produced using one-tenth of the propellant required by conventional chemical propulsion systems; this greatly reduces spacecraft size and mission costs.

Solar Arrays

The Deployable Space Systems (DSS) Roll Out Solar Arrays (ROSA) and Orbital ATK MegaFlex solar arrays were developed for SEP missions like those NASA is planning. Large-scale arrays can be stowed at launch and then unfurl to capture solar energy that is converted into electricity. A pair of these large-scale arrays can provide approximately 50 kilowatts of electrical power.



Solar array technologies being advanced for SEP include: (top) the ROSA; (bottom) MegaFlex solar array. Solar arrays will convert energy from the Sun into electricity used to power the thrusters.

Hall Thrusters

The high-power SEP systems under development use electrostatic Hall thrusters instead of chemical rocket engines. A Hall thruster uses electricity and xenon gas to

NASA facts

create a plasma comprising of electrons and ions. The thruster electric field accelerates xenon ions to extremely high velocities and expels them to produce the thrust that propels a SEP spacecraft.

Power Processing Units

High-voltage power processing units condition electricity generated by solar arrays into voltages and currents needed to operate Hall thrusters.

Combining SEP technologies enables high-fuel-efficiency space flight missions beyond low Earth orbit at much lower mass and cost than is achievable with conventional chemical propulsion systems.

Capability Demonstration Mission

The Asteroid Redirect Robotic Mission (ARRM) is a capability demonstration mission of high-power SEP supported by NASA's Human Exploration and Operations Mission Directorate, Space Technology Mission Directorate, and Science Mission Directorate. ARRM will use a robotic spacecraft equipped with a high-power SEP system to visit a large near-Earth asteroid, collect a multiton boulder from its surface, and conduct an asteroid deflection demonstration. The spacecraft will then redirect the multiton boulder into a stable orbit around the moon, where astronauts will explore it and return with samples in the mid-2020s.

The Future: Proving Ground Missions on NASA's Journey to Mars

NASA is developing and demonstrating SEP technologies needed to affordably enable human missions to Mars. A high-power solar electric power and propulsion spacecraft (bus) can be used to transport cargo, payloads, and other spacecraft elements required for crewed exploration beyond low Earth orbit. The SEP technology enables a range of other commercial and government missions.

Glenn Leads SEP for the Agency

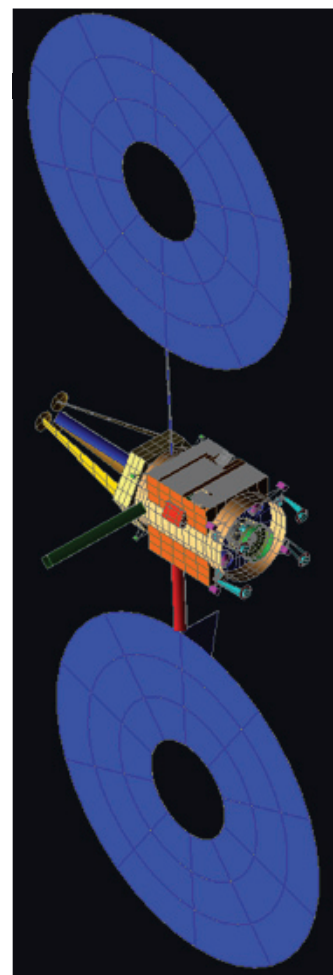
NASA Glenn Research Center in Cleveland, Ohio, is the lead NASA center for solar electric propulsion. Glenn performs in-house SEP technology development activities and oversees SEP contracted efforts (like the DSS and Orbital ATK solar array developments) as well as teamed efforts supported by contractors at the NASA Jet Propulsion Laboratory. NASA Glenn also recently awarded a contract to Aerojet Rocketdyne for development of a high-power Hall thruster, power processing unit, and xenon flow controller to be used on SEP missions.

Key Facts

- Solar electric propulsion allows deep-space missions to carry more cargo and use smaller launch vehicles while reducing mission costs.
- The Solar Electric Propulsion project has developed solar arrays that are lighter, stronger, more compact, and less expensive than those currently available.
- Solar electric propulsion provides such high fuel economy that it reduces the amount of propellant required onboard vehicles for deep-space missions by as much as 90 percent.
- Solar electric propulsion will enable affordable human-crewed missions beyond low Earth orbit.



The Hall Effect Rocket with Magnetic Shielding (HERMeS) thruster. Here the HERMeS Technology Development Unit is shown during testing in Vacuum Facility-5 at Glenn Research Center.



A NASA-developed spacecraft concept that could perform the ARRM.

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